

# Diphyllobothriasis after Eating Raw Salmon

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An 11-year-old boy in Hawaii passed mucus and a moving object in his stool. The object was identified as a segment of the fish tapeworm *Diphyllobothrium* species which is not indigenous to Hawaii. *Diphyllobothrium* ova were also found in the stool. The only raw fish he recalled eating in previous months were tuna sushi and lomi-lomi salmon which usually contains raw but previously frozen salmon. Of these two fish, only salmon which is not native to Hawaiian waters, has been incriminated as a significant source of diphyllobothrium fish tapeworm infection. Freezing kills this parasite, however, we speculate that the raw fish in the lomi-lomi salmon that our patient had eaten had not been pre-frozen or was not adequately pre-frozen. Eating raw salmon without certainty that it has been adequately pre-frozen carries the risk of diphyllobothriasis or fish tapeworm infection.

## Introduction

The custom of eating raw seafood has become increasingly popular in the United States over the past two decades largely due to Asian influences. Sashimi (sliced bite-size pieces of raw fish and other seafood delicacies), sushi (small portions of seafood pressed onto rice patties) and lomi-lomi salmon (chopped raw salmon, tomatoes, onions, green peppers and soy sauce) are popular foods in Hawaii that are currently consumed in increasing quantities at trendy Japanese restaurants across the United States. Many of these seafood delicacies harbor parasites that may be harmful to humans and raw salmon is foremost among them. We report a child with diphyllobothriasis who had previously eaten foods containing raw salmon and tuna. Of these two fish, only salmon which is not native to Hawaiian waters, has been incriminated as a source of diphyllobothrium fish tapeworm infection.

## Illustrative Case

An 11-year-old boy presented to our Pediatric Clinic with the chief complaint of passage of mucus and a moving object in his stool. He denied other symptoms and physical examination was within normal limits except for moderate obesity. The stool specimen he brought with him contained a three by one centimeter tapeworm segment consisting of 17 proglottids (Figure 1A) of the fish tapeworm *Diphyllobothrium* species. A smaller segment of four proglottids was fixed, sectioned and stained and the segmental nature of the proglottids which are characteristically wider than they are long is evident. Centrally positioned rosette shaped uteri containing numerous ova are seen in each proglottid (Figure 1B). Numerous identical ova were seen in stool wet-mount preparations (Figure 1C). These ova, on higher magnifications, exhibit opercula on one end with abopercular knobs characteristic of *Diphyllobothrium* species (Figure 1D). On questioning the child recalled having eaten raw tuna sushi and lomi-lomi salmon, which usually contains raw but previously frozen salmon, within the previous three months. He was treated with a single dose of praziquantel; 600 mg orally. He was asked to bring in any further suspected worm parts in his stool for identification but none were seen and his stools returned to normal the following day. Repeated stool examinations from the patient and all members of his family were negative for proglottids or ova.

## Discussion

Diphyllobothriasis in North America has been most commonly associated with *D. latum* acquired from eating uncooked or inadequately cooked fresh water fish from the waters of Alaska, Canada and the Great Lakes regions of the United States.<sup>1</sup> Salmon have been the most common cause of infection with this parasite in Japan.<sup>2</sup> The custom of eating raw fish has become increasingly popular in western cultures over the past two decades and eating raw salmon may now be the major source of diphyllobothriasis in the United States.<sup>3,4</sup> Cooking infected fish for at least 56° C for five minutes or freezing at -18° C for 24 hours or -10° C for 72 hours kills *Diphyllobothrium* species rendering infected fish safe to eat.<sup>3</sup>

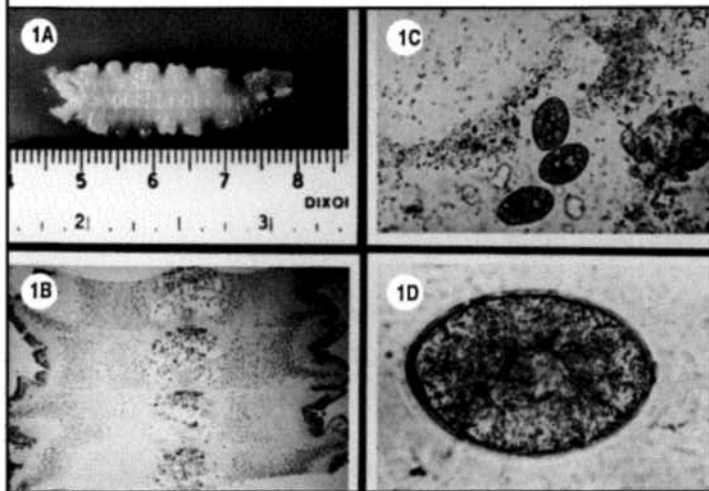
Species identification of the genus *Diphyllobothrium* requires examination of the intact worm including the scolex, strobila and individual proglottids which was not recovered from our patient.<sup>1,4,5</sup> Of the 12 species of *Diphyllobothrium* only a few have been found to infect man: *D. latum*, *D. dendriticum*, *D. pacificum*, *D. ursi*, and *D. klebanovskii*.<sup>6</sup> *Diphyllobothrium dendriticum*, *D. uri* and *D. klebanovskii* have most often been incriminated in Alaskan salmon infections and one of these species was probably the cause

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Key Words: diphyllobothriasis, diphyllobothrium, salmon, sushi, sashimi, fish tapeworm

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Fig. 1A - 1D.—Diphyllobothriasis After Eating Raw Salmon  
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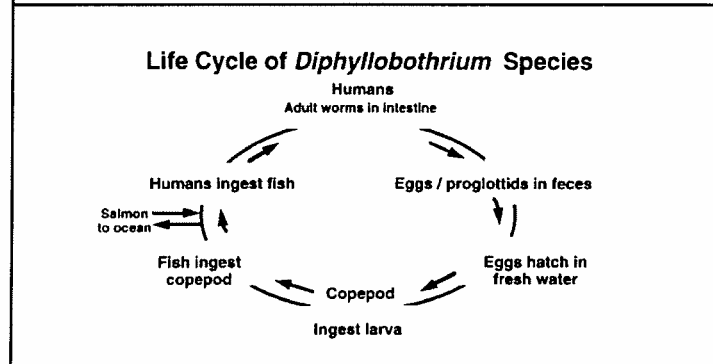
1A.—The strobila or chain of proglottids of the tapeworm *Diphyllobothrium* species that was passed in the patient's stool. 1B.—Fixed, sectioned and stained segment of four proglottids each showing central rosette shaped uteri with small dot-like ova within (X 10). 1C.—Operculated ova of *Diphyllobothrium* species in a wet-mount preparation of the patient's stool (X 200). 1D.—Same ova under higher magnification (X 1000).

of infection in our patient.<sup>7</sup> Of the two types of raw fish he had eaten, tuna, which are pelagic fish, do not harbor this parasite while salmon, which are anadromous fish which must leave the ocean to spawn in fresh water rivers and lakes, have zoologic studies documenting a high rate of *Diphyllobothrium* infection.<sup>3</sup> We speculate that the raw fish in the lomi-lomi salmon that our patient had eaten had not been pre-frozen or was not adequately pre-frozen.

Most commercial salmon in the United States come from Alaska where the fish are shipped to markets frozen. In recent years there has been a trend to ship fresh unprocessed Alaskan salmon to markets when processors are overwhelmed by large salmon runs. In 1980 such a bumper catch of salmon occurred in Alaska and a large number were flown fresh chilled but unfrozen to market in other states primarily those along the west coast.<sup>3,4</sup> Prior to 1982 the Parasitic Disease Drug Service at the Centers for Disease Control was the only source of niclosamide in the United States and in 1980 there was a deluge of requests for this drug from physicians to treat patients with diphyllobothrium tapeworm infection. There were 17 requests in 1979 while there were 59 in 1980. Of 39 of these patients interviewed all recalled eating raw salmon and all denied eating any other fish known to transmit fish tapeworm infection.<sup>4</sup> The following year niclosamide was licensed for general use in the United States so there is no record of how often this drug has been used to treat diphyllobothriasis since 1982.

In addition to being a source of diphyllobothrium infection salmon may harbor anisakis parasites.<sup>8-10</sup> In a survey of 50 wild caught salmon taken off the Washington coast all were infected with *Anisakis simplex*.<sup>8</sup> Eating raw fish infected with this parasite has been associated with severe gastrointestinal symptoms and complications including intestinal perforation. The only treatment for anisakiasis is surgical or endoscopic removal of the parasite.<sup>11</sup> A patient in Hawaii has been reported who developed severe gastrointestinal symptoms after eating raw lomi-lomi salmon.<sup>12</sup> During endoscopic examination an *Anisakis simplex* worm embedded in the

Fig. 2.—Diphyllobothriasis After Eating Raw Salmon  
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Life cycle of *Diphyllobothrium* species. Salmon become infected during the fresh water phase of their life-cycle. Young fingerlings may eat many types of fresh water crustaceans including copepods in route to the ocean. Mature salmon return from the ocean to spawn and die. Infection can occur when salmon taken from either the ocean or from fresh water are eaten raw by mammals.

gastric mucosa, was removed. When lomi-lomi salmon purchased at a commercial market in Hawaii was examined numerous worm fragments and whole viable *Anisakis simplex* worms were found. In their review the authors concluded that in nearly all known human cases of anisakiasis with tissue involvement in the United States, salmon were the source of infection. Cooking to at least 60° C for five minutes or freezing at -20° C for 60 hours prevents this infection.<sup>3</sup>

Several studies have shown that parasitic infection from eating raw fish occurs most commonly when the food is prepared at home and that it rarely occurs from consuming raw fish at sushi bars in Japanese restaurants.<sup>13</sup> However, as recently as 1989 a survey of 23 sushi bars in New York City revealed that all served raw salmon.<sup>14</sup> It has been shown that cold smoking and most methods of marinating and brining cannot be relied on to kill anisakid worms and visual inspection can not be counted on to reveal all larvae.<sup>13</sup> Unless the raw salmon served in these and other sushi bars or raw salmon purchased for home consumption has been pre-frozen, there is risk of infection with anisakid roundworms, as well as diphyllobothrium tapeworms, when this fish is eaten raw.

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